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Myriapods (Myriapoda) Chapter 7.2

Pavel Stoev[1], Marzio Zapparoli[2], Sergei Golovatch[3], Henrik Enghoff[4], Nesrine Akkari[5], Anthony Barber[6]

1 *National Museum of Natural History, Tsar Osvoboditel Blvd. 1, 1000 Sofia, Bulgaria* **2** *Università degli Studi della Tuscia, Dipartimento di Protezione delle Piante, via S. Camillo de Lellis s.n.c., I-01100 Viterbo, Italy* **3** *Institute for Problems of Ecology and Evolution, Russian Academy of Sciences, Leninsky prospekt 33, Moscow 119071 Russia* **4** *Natural History Museum of Denmark (Zoological Museum), University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, Denmark* **5** *Research Unit of Biodiversity and Biology of Populations, Institut Supérieur des Sciences Biologiques Appliquées de Tunis, 9 Avenue Dr. Zouheir Essafi, La Rabta, 1007 Tunis, Tunisia* **6** *Rathgar, Exeter Road, Ivybridge, Devon, PL21 0BD, UK*

Corresponding author: *Pavel Stoev* (pavel.e.stoev@gmail.com)

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Abstract

Alien myriapods in Europe have never been subject to a comprehensive review. Currently, 40 species belonging to 23 families and 11 orders can be regarded as alien to Europe, which accounts approximately for about 1.8% of all species known on the continent. Millipedes (Class Diplopoda) are represented by 20 alien species, followed by centipedes (Class Chilopoda) with 16, symphylans with 3 and pauropods with only 1. In addition there are numerous cases of continental species introduced to the Atlantic and Mediterranean islands or others of southern origin transported and established in North European cities. The earliest record of an alien myriapod dates back to 1836, although the introduction of some species into Europe could have begun already in historical times with an increase in trade between ancient Greeks and Romans with cities in the Near East and North Africa. In post-medieval times this process should have intensified with the trade between Europe and some tropical countries, especially after the discoveries of the Americas and Australia. The largest number of alien myriapods (25, excl. intercepted) has been recorded from Great Britain, followed by Germany with 12, France with 11 and Denmark with 10 species. In general, northern and economically more developed countries with high levels of imports and numerous busy sea ports are richer in alien species. The various alien myriapods have different origins, but most of them show tropical or subtropical links (28 species, 70%). Eight of them (20%) are widespread in the Tropical and Subtropical belts, eleven (circa 28%) are of Asian origin, seven show links with South and Central America, and one each originates from North America, North Africa, Australasia, and islands in

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the Indian Ocean. Ten myriapods are of unknown origin (cryptogenic). Only 12 species (*ca.* 30%) of all have established in the wild in Europe. At the present time alien myriapods do not cause serious threats to the European economy and there is insufficient data on their impact on native fauna and flora.

Keywords
Diplopoda, Chilopoda, Symphyla, Pauropoda, Europe, alien, invasions, intercepted species, biogeographical patterns

7.2.1. Introduction

Myriapods are terrestrial wingless arthropods with elongated bodies composed of more or less similar segments, most of which bear one or two pairs of legs. Four classes are recognised: Pauropoda, Symphyla, Chilopoda and Diplopoda. Approximately 15 000 species from nearly 160 families are currently known in the world. The Diplopoda is by far the most diverse group, comprising roughly 11 000 species (Adis and Harvey 2000). A total of 2,245 myriapod species or subspecies from 15 orders and 70 families are currently known in Europe (http://www.faunaeur.org/statistics.php), of which 1,529 are Diplopoda, 481 Chilopoda, 41 Symphyla and 125 Pauropoda. All members of the class Diplopoda (millipedes) have two pairs of legs per diplosegment for most segments. Several morphotypes have been recognised, i.e. juloid, polydesmoid, polyxenoid, platydesmoid and glomeroid (Kime and Golovatch 2000), of which the former two are especially rich in species both in Europe and worldwide. Most of the species are cylindrical or flattened dorsally, often with prominent lateral projections, generally medium- to large-sized (up to 8–9 cm in the genera *Pachyiulus* and *Eurygyrus*). Some species of the order Glomerida, or pill millipedes, are oniscomorph, capable of rolling up into a tight ball. Members of the order Polyxenida, or "dwarf millipedes", are minute in size and with peculiar hairs along the body arranged in groups and tufts like small pin-cushions or brushes. The number of legs varies between species, often (especially in juloids) even individually, the record being 375 pairs in the North American siphonophoridan species *Illacme plenipes* Cook & Loomis, 1928 (Marek and Bond 2006).

Species of the class Chilopoda (centipedes) have an elongated flattened trunk and bear one pair of legs per segment, with a total number ranging between 15 and 191 pairs. Centipede body length varies from a few millimeters in some species of genus *Lithobius* (*Monotarsobius*) to approximately 30 cm in the Neotropical species *Scolopendra gigantea* (Minelli and Golovatch 2001). All centipedes have a pair of poison claws, or forcipules, which represent modified first body appendages. About 3,500 valid species and subspecies from 5 orders and 22 families are known in the world (Minelli 2006, Edgecombe and Giribet 2007). The other two myriapod classes – Symphyla and Pauropoda – consist of very small species, with body length of 2–8 and 0.5–1.9 mm respectively, both still remaining very poorly studied. The number of described symphylans and pauropods in the world is roughly estimated to about 200 and 700, respectively (Adis and Harvey 2000).

Most millipedes, as well as all pauropods and symphylans, are phytophages, detritivores or saphrophages. A few millipedes can be regarded as omnivores, e.g. *Blaniulus guttulatus* (Fabricius, 1798), *Uroblaniulus canadensis* (Newport, 1844), or even predators, like *Apfelbeckia insculpta* (L. Koch, 1867), *Callipus foetidissimus* (Savi, 1819), and *Abacion magnum* (Loomis, 1843), which have been observed feeding on earthworms, flies and spiders (Hoffman and Payne 1969, Golovatch 2009). Other species feed on their own exuvia or fecal pellets (Minelli and Golovatch 2001).

Centipedes are mostly predatory, feeding on different available prey items in the soil (earthworms, enchytraeids, snails, slugs, small insects – both larvae and adults – and other arthropods). More details on the biology and ecology of millipedes, centipedes and the two other, smaller myriapod classes can be found in Hopkin and Read (1992), Lewis (1981), and Verhoeff (1933, 1934).

Little information is as yet available on the non-indigenous myriapods in Europe (DAISIE 2009, Roques et al. 2009). The most recent overview of alien organisms in Europe (see DAISIE 2009, p. 225) lists two centipedes (*Lamyctes emarginatus*, *Lamyctes caeculus*) and three millipedes (*Oxidus gracilis*, *Eurygyrus ochraceus*, *Sechellobolus dictyonotus* = *Paraspirobolus lucifugus*) as alien to Europe. Some papers have been, however, published on the ecology, morphology and post-embryonic development of several alien centipedes (Andersson 1984, 2006, Bocher and Enghoff 1984, 1975a, Negrea 1989) and millipedes (Enghoff 1975b, 1978, 1987, Golovatch et al. 2000, et al. 2002). Lists of alien species have been published for a few countries only, such as Germany (Kinzelbach et al. 2001), Austria (Gruber 2002, Gruber and Christian 2002), the Czech Republic (Šefrová and Laštůvka 2005), Switzerland (Wittenberg 2005), Italy (Zapparoli and Minelli 2005) and Great Britain (Barber 2009a, b). Increasing attention has been paid in the last decades to species which have accidentally arrived in Europe (see Barber 2009a, BBC News 2005, Christian and Szeptycki 2004, Gregory and Jones 1999, Lewis 1988, Lewis and Rundle 1988 for centipedes and Andersson and Enghoff 2007, Enghoff 2008a and Read 2008 for millipedes).

7.2.2. Taxonomy of the myriapod species alien to Europe

Altogether, 40 species belonging to 23 families and 11 orders can be regarded as alien to Europe (Table 7.2.1). This accounts approximately for about 1.8% of all myriapods known on the continent. Millipedes are represented by 20 alien species, followed by centipedes with 16, symphylans with 3 and pauropods with only 1. The relative proportion of alien species is highest in Symphyla (7.3%) and Chilopoda (3.3%), and the lowest in Pauropoda (0.8%) and Diplopoda (1.3%). The centipede family Henicopidae is the richest in alien species (5 species), followed by Scutigerellidae, Mecistocephalidae, Scolopendridae, Paradoxosomatidae and Pyrgodesmidae, each with three species. The remaining 17 families are represented by only one or two species each (Figure 7.2.1).

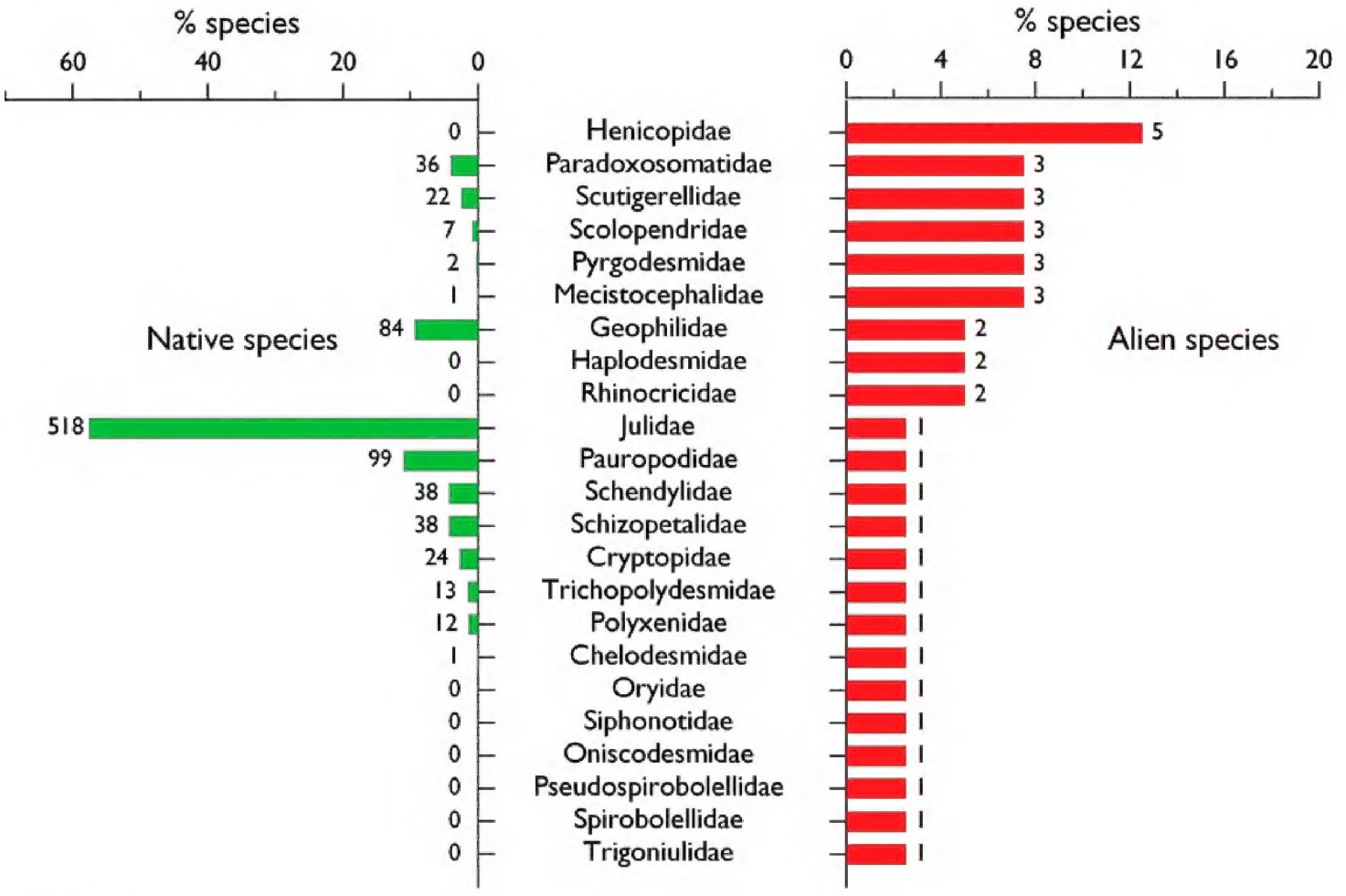

Figure 7.2.1. Relative importance of each family in the alien (right side) and native (left side) myriapod fauna in Europe. Number near the bar indicates the number of species. Families are listed in a decreasing order based on the number of alien or, in alternative, native species.

Striking is the absence of alien species in Europe of the species-rich order Spirostreptida since spirostreptidans, for instance *Hypocambala anguina* (Attems, 1900) and *Glyphiulus granulatus* Gervais, 1847, are quite widespread in the tropical countries and show a clear tendency to anthropochorism (Jeekel 1963, Shelley 1998).

Several myriapods have been intercepted at their arrival in Europe from consignments from other countries but have never managed to establish themselves. Barber (2009a) provided a list of centipede species captured and registered by the Central Science Laboratory (now FERA) in the UK when imported with exotic plants, fruits and luggage (Table 7.2.2). Two of them, *Lithobius forficatus* and *L. peregrinus*, are European natives which have long been introduced to Australia and New Zealand, so their interception in Great Britain is a clear case of re-introduction.

A similar list for intercepted millipedes examined by the Central Science Laboratories between 1975 and 2006 (S. Reid *pers. comm.*) is more substantial with some 85 entries over this period of time (Table 7.2.2). Of these 36 were records of *Oxidus gracilis* from a wide range of different parts of the world (W & S. Europe, Canary Islands, Israel, N., C. and S. America, Australia, China, Japan, Malaysia, Singapore, India, Nepal, N., W. and S. Africa and Madagascar). Other types found included members of the Polydesmida (dalodesmids, parodoxomatids, polydesmids), Spirosteptida (from Australia, New Zealand and Africa), Julidae and Blaniulidae. Amongst species from the latter two families were the NW European *Blaniulus guttulatus* and *Cylindroiulus*

londinensis (both from Australia) and *Ommatoiulus moreletii* (originating in the Iberian Peninsula, introduced to Australia in 1953 and now a pest species there; in this list reported from both that country (tree fern) and South Africa (melon fruit)).

Man-aided introductions of species from one part of Europe to another have played a prominent role. One of the most common synanthropic centipedes in North Europe is the Mediterranean "house centipede" *Scutigera coleoptrata* (Linnaeus, 1758). It has been introduced to a number of North European cities, e.g., Copenhagen, Edinburgh, Aberdeen, Leiden, etc., where it survives only in buildings. The earliest record in the British Isles of this species is perhaps that by Gibson-Carmichael (1883) who recorded it from a paperworks near Aberdeen. It could have been established there already for 25 years and arrived in bundles of rags from South Europe (Barber 2009a); at the present time it is sporadically reported from inside buildings in various parts of Britain and seems to be common in houses in St. Peter Port (Guernsey) and St. Helier (Jersey) in the Channel Islands from where it has also been reported from outdoor sites. Other cases of south or central European species being introduced to northern countries that perhaps still survive only in buildings, hothouses, gardens or similar man-made habitats are: *Tuoba poseidonis* (Verhoeff, 1901) in Finland, *Dicellophilus carniolensis* (C.L. Koch, 1847), *Lithobius lucifugus* L. Koch, 1862, *Lithobius peregrinus* Latzel, 1880, *Haplopodoiulus spathifer* (Brölemann, 1897) and *Cylindroiulus salicivorus* Verhoeff, 1908 in Great Britain, *Cylindroiulus vulnerarius* (Berlese, 1888) in Sweden, *Pachyiulus varius* (Fabricius, 1781) in Norway, etc. (Barber 1995, Barber and Eason 1986, Barber and Keay 1988, Bergersen et al. 2006, Lee 2006, Read 2008).

Even within the same geographic area some indigenous species occur at localities that are not part of their primary distribution area, most probably as a consequence of accidental anthropogenic introductions. Examples are the records from Italy of *Lithobius infossus* Silvestri, 1894 near Padua (Minelli 1991), of *L. peregrinus* Latzel, 1880 in northeastern and central Italy (Minelli 1991, Zapparoli 1989, Zapparoli 2006), of *Pleurolithobius patriarchalis* (Berlese, 1894) in the Egadi, Pontine and Campania islands (Zapparoli and Minelli 1993), and of *Scolopendra cingulata* near Milan (Manfredi 1930).

Island invasions by continental species is another phenomenon worth mentioning. Eason in a study on the Icelandic fauna, concluded that most centipede and millipede species probably arrived by human transport (Eason 1970). Examples of recent introductions to Iceland are *Geophilus truncorum* Bergsøe & Meinert, 1866, *Polydesmus inconstans* Latzel, 1884, and *Brachydesmus superus* Latzel, 1884, which "... have only been found on Heimaey, one of the Vestman Islands, which supports a town and where casual introduction by human transport is likely: they have probably been introduced quite recently and the two millipedes seem still to be confined to the outskirts of the town". Regarding the other two possibly allochthonous species, *Lithobius forficatus* (Linnaeus, 1758), and *Lithobius erythrocephalus* C.L. Koch, 1847, Eason wrote, "these two species may be confined to the south owing to the relatively warm and humid southern climate, but their restricted distribution might also be explained by their having been introduced by Norse settlers ....". The first Norse set-

tlements on Iceland were established in the ninth century A.D., so this must have happened after that time.

According to Enghoff (2008b), of the 21 species of centipedes recorded in Madeira 17 are introduced and 2 are probably introduced. High rates of introduction are also known for the Azores and Canary Islands (Borges and Enghoff 2005, Zapparoli and Oromi 2004) (Table 7.2.3). All symphylans on the Canary Islands have been considered as possibly introduced. Likewise, only two of 21 millipede species are considered native on the Azores (Enghoff and Borges 2005).

The geophilomorph centipede *Nyctunguis persimilis* Attems, 1932 was originally described from Turkey and has not been found there since in spite of the active work of the second author who has published several papers on the Turkish centipede fauna during the last 20 years. Taking into account that the species was recently found in synanthropic habitats in the outskirts of Vienna (Christian 1996) and that all other congeners occur in the Nearctic region, it is very likely that the type locality (the surroundings of Ankara, Turkey) is erroneous and the material was actually mislabeled (Zapparoli 1999).

Mecistocephalus maxillaris (Gervais, 1837), one of the first alien centipedes to be recorded in Europe, is another poorly known species. It was described from the gardens of the Muséum National d'Histoire Naturelle, Paris, and subsequently recorded from numerous places around the world. However, most of the records were certainly based on misidentifications with the morphologically similar *M. guildingii* or *M. punctifrons* actually being involved (Bonato et al. 2009). According to Bonato et al. (2009), most of the records in Europe e.g., those from Germany, Great Britain, France (not the type specimen but material taken subsequently from a greenhouse in the Paris Museum, cf. Brolemann 1930) and Portugal (Madeira), are referable to *M. guildingii*, while those from the Netherlands and Denmark require further clarification.

The actual taxonomic status and native range of *Ghilaroviella* cf. *valiachmedovi* remains uncertain. The same applies to the millipede *Chondrodesmus* cf. *riparius* which shows some differences from the original description by Carl (1914) and its identity cannot be clarified without a comprehensive review of the entire genus (Enghoff 2008a).

7.2.3. Temporal trends in the introduction of alien myriapod species to Europe

Introductions of alien myriapods into Europe probably began several centuries ago, even though a precise arrival date is hard to determine. Only 10 out of 40 species were recorded for the first time in Europe in the 19th century while most of the records date from the 20th (26 species) and 21st centuries (4 records).

Gervais was virtually the first person to record alien myriapods in Europe (Gervais 1836, 1837). He described the tropical millipede *Iulus lucifugus* (now *Paraspirobolus lucifugus*) and the geophilomorph centipede *Mecistocephalus maxillaris* from greenhouses of the Paris Museum. The means of arrival of both species remains obscure but

must be linked to the establishment of the greenhouses and the planting of tropical flowers, perhaps already by the end of the 18th century. *P. lucifugus* has been subsequently recorded in intervals of around 60–70 years from greenhouses near Hamburg (Latzel 1895), Hortus Botanicus Amsterdam (Jeekel 1977), a greenhouse in Copenhagen (Enghoff 1975b), and more recently from the Tropical Biome at the Eden project (Lee 2006). This can hardly be regarded as reflecting the actual course of colonization but rather the date of investigation and the level of effort involved in each case.

The only alien millipede that has invaded some natural ecosystems in Europe and acclimatized is the East Asian species *Oxidus gracilis*. Perhaps the earliest records of this species in Europe are those of Tömösváry (1879) from the Margaret Island in Danube, Hungary, and of Latzel (1884) from greenhouses in Zeist, Utrecht, and Amsterdam in the Netherlands. Subsequently it was also found in Edinburgh in 1898 and in Kew Gardens in Great Britain (Evans 1900, Pocock 1902). In Finland the species was first recorded in 1900, but since the sample already contained several specimens the species must have arrived there at least two years earlier (Palmén 1949). The mechanism of dispersal of the species within Europe is certainly related to the trading and growing of tropical plants in the greenhouses as in some places this process must have happened more than once. According to Palmén (1949), the population of *O. gracilis* in the greenhouses of Hanko, South Finland went extinct during the period 1939–1943 when they were not kept warm. In 1946 a single female was found in a greenhouse with plants imported from Belgium, in 1947 its numbers increased considerably and the next year it was already very abundant in the whole greenhouse complex.

Golovatch (2008) suggested that the intense trade ties between the ancient town of Khersonesos in the Crimea and the town of Pergam (= Bergama), a major centre of red ceramics production of the time in present-day Turkey, as possible pathways for the introduction of *Eurygyrus ochraceus* in the Ukraine. He also pointed out that the Bulgarian population near Varna may owe its origin to the very active commerce in Roman times between Bergama and the colonies in Moesia (= currently northern Bulgaria and southern Romania), including Odessos (= Varna). The area and trade connections were already quite developed by the mid-4th century B.C. or even earlier, under ancient Greeks, so this introduction must have happened around that time.

Members of the genus *Lamyctes* are represented in Europe only by parthenogenetic populations. Males of *L. emarginatus* are known only from Macaronesia, New Zealand, Tasmania and Hawaii (see also Attems (1935) and Zapparoli (2002) for the record of a single male from Greece), while males of *L. coeculus* are only known from a greenhouse in Italy and from Cuba (Enghoff 1975a). Taking into account that the entire family Henicopidae is predominantly distributed in the Southern Hemisphere, and presuming that the regions where males are being found are the native areas of the species, *L. emarginatus* could have been introduced to Europe from one of the above regions, most likely from Australia or New Zealand. The earliest confirmed record is from Denmark in 1868 (see Meinert 1868). *Lamyctes coeculus* was first found in a greenhouse in Italy at the end of 19th century (Brölemann 1889), but its presence in the area would have been older. It has been recently found in Great Britain (Barber 2009b).

The earliest records of *Cylindroiulus truncorum* in Europe date from the 1920's and, according to Schubart (1925), the Central European populations are probably of relatively recent origin. In Finland it was first reported in 1945 and in the following three years its numbers increased considerably. It is completely lacking in older collections (Palmén 1949).

One of the recent introductions is the large Neotropical millipede *Chondrodesmus* cf. *riparius* which was first recorded in 2000 in a flowerpot in the telephone office of Umeå University, northern Sweden. It was found again elsewhere in Sweden in 2006 and, later, in January 2007, it was also recorded in a flowerpot with a palm (*Phoenix robbelini*) in an office in Copenhagen and in a flowerpot in Bonn (Enghoff 2008a). There are further records of the species from flowerpots in Germany and also a recent one in Norway (Göran Andersson in litt.), so it seems that the species is dispersing well with palm pots.

The study of the invertebrate fauna of Kew Gardens, Great Britain began already at the beginning of 20th century with papers by Pocock (1902, 1906) and continues today (Blower and Rundle 1980, 1986, Read 2008). Some of the species recorded by Pocock such as *Scolopendra morsitans*, *Trigoniulus corallinus* and *Asiomorpha coarctata* have not been re-found since then and most likely could not become established in Kew Gardens. At the same time *Paraspirobolus lucifugus*, *Amphitomeus attemsi*, *Cylindrodesmus hirsutus*, *Rhinotus purpureus* and *Pseudospirobolellus avernus*, species not previously known from Britain have been recorded recently in the Tropical Biome at the Eden project in Cornwall (Read 2008, Barber 2009b, Barber et al. 2010).

7.2.4. Biogeographic patterns of the myriapod species alien to Europe

Records of exotic species are not evenly distributed in Europe but this is mainly due to the different levels of investigation of this area. The highest number of species (25) has been recorded from Great Britain, followed by Germany with 12, France with 11 and Denmark with 10 alien myriapods (Figure 7.2.2). In general, northern and economically more developed countries with high levels of imports and numerous busy sea ports are richer in alien species. These countries also, in general, have poorer native faunas meaning that a small number of aliens can constitute a large percentage of the fauna. Several species are hitherto known in Europe from a single country only, e.g. *Prosopodesmus panporus*, *Pseudospirobolellus avernus*, *Tygarrup javanicus* and *Cryptops doriae*, which implies recent introductions or poor dispersal abilities. Others, such as *Eurygyrus ochraceus*, *Paraspirobolus lucifugus* and *Lamyctes coeculus*, have a larger but yet fairly restricted distribution limited to two or more countries. The most widespread species are the parthenogenetic centipede *Lamyctes emarginatus*, whose range in Europe spreads from the Urals to Iceland [outdoor species], and the bisexual millipede *Oxidus gracilis*, reported from 33 countries, including several Mediterranean islands.

The various alien myriapods have different origins, but most of them show tropical or subtropical links (28 species, 70%). Eight of them (20%) are widespread in the Tropical and Subtropical belts, very often introduced by human agency to islands and synanthropic areas on continents. Their native range cannot so far be determined with certainty (Figure 7.2.3). Eleven (circa 28%) alien myriapods are of Asian origin, the majority (10 species) having their native range in East or Southeast Asia, and only one from West Asia, namely Anatolia. *Cylindroiulus truncorum* is perhaps the only North African myriapod introduced to Europe just as *Brachyiulus pusillus* (Leach, 1814) so far is the only European julid introduced to North Africa (Akkari et al. 2009). The only species that seems to be an Australasian native (Australia and New Zealand) is *Lamyctes emarginatus*. Among henicopids, *Rhodobius lagoi* and *Ghilaroviella* cf. *valiachmedovi* are of particular interest being members of monotypic genera and the only representatives in Europe of the subfamily Anopsobiidae which comprises chiefly species with Gondwanan distribution patterns. Besides *Rhodobius*, four other monotypic genera represent the subfamily in the Northern Hemisphere, occurring in Vietnam, Japan, Kazakhstan, and Tajikistan (Edgecombe 2003, Farzalieva et al. 2004). Of Central or South American origin are seven species (circa 18%), and one each from North America and islands in Indian Ocean. The sole record of the pantropical geophilomorph centipede *Orphnaeus brevilabiatus* in Europe comes from Bohuslän, a Swedish province in the northern part of the W coast, where the animal was collected in the 19th century (Andersson et al. 2005).

Ten centipedes and millipedes have been considered as cryptogenic (= species of unknown origin which cannot be ascribed as being native or alien). Some of them such as the geophilid *Arenophilus peregrinus* and the schendylid *Nyctunguis persimilis*, which have only been reported from the Isles of Scilly, Great Britain and Austria respectively (Barber 2008, Christian 1996) whereas all the other species of these genera live in North America, are of likely Nearctic origins. Another suspected introduction of uncertain origin is *Nothogeophilus turki* which has hitherto been known only from Scilly and the Isle of Wight, Great Britain (Lewis et al. 1988) and represents a monotypic genus. However, we cannot completely exclude the possibility that some cryptogenic species suspected to be alien are actually native to Europe. Support for this notion we find in the scolopendromorph centipede *Theatops erythrocephalus* C.L. Koch, 1847, which occurs in various natural habitats (including caves) in the Pyrenees and the western part of the Balkans (with a gap between these geographic areas), while all its other four congeners occur in North America (Minelli 2006).

Unknown also is the origin of the symphylid *Hanseniella oligomacrochaeta* described from a hothouse in the Botanical Garden in Berlin; according to Scheller (2002), all species in the genus *Hanseniella* have tropical-subtropical distributions. The haplodesmid *Prosopodesmus panporus* is only known from the Royal Botanic Gardens in Kew, England, while its other described congener, *P. jacobsoni* Silvestri, 1910, is pantropical (Golovatch et al. 2009). Likewise, it is uncertain whether *Napocodesmus endogeus*, a millipede described solely from females collected in the garden of Cluj University, is a European native or not. According to Tabacaru et al. (2003), the generic allocation

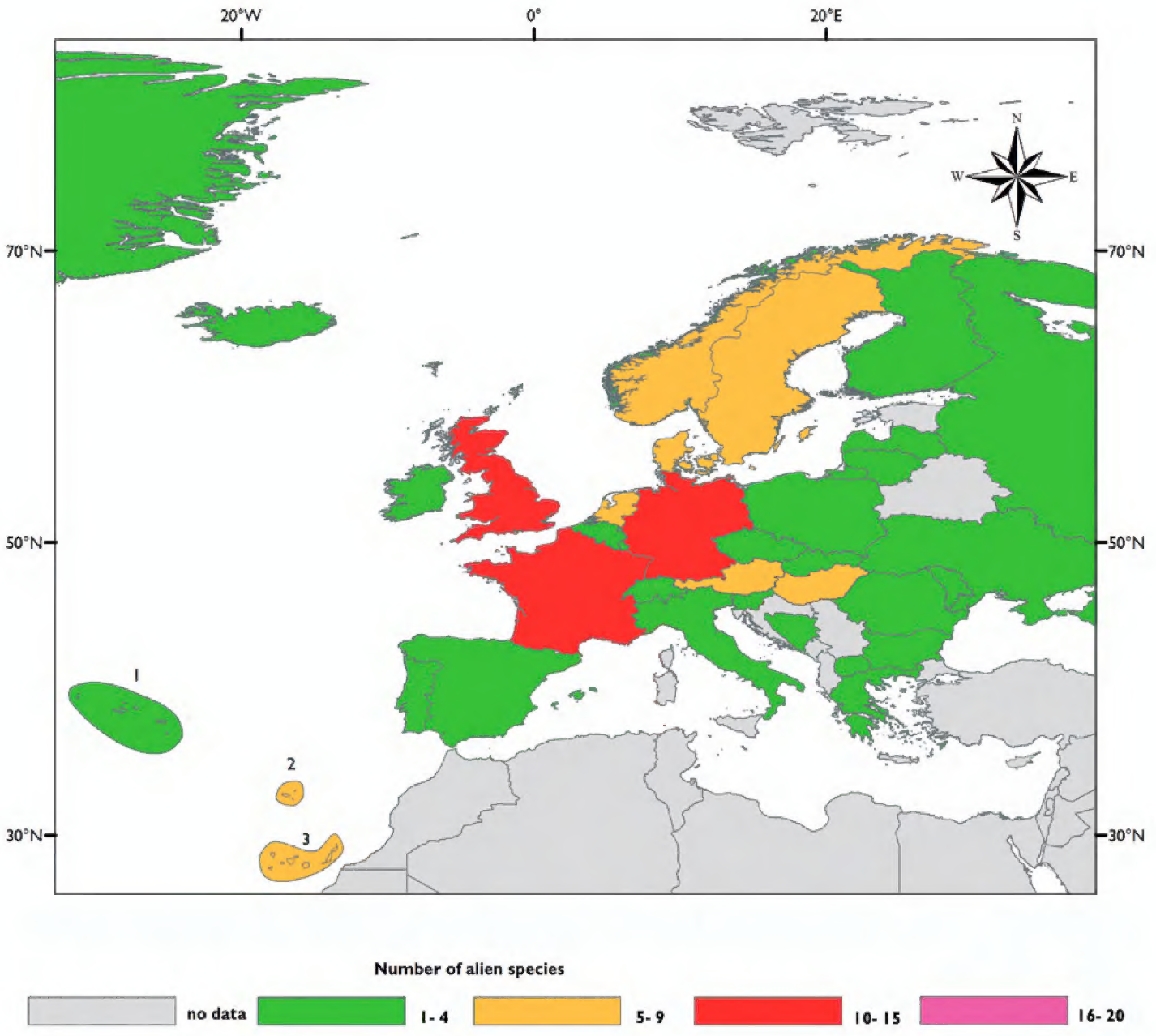

Figure 7.2.2. Colonization of continental European countries and main European islands by myriapod species alien to Europe. Archipelago: **1** Azores **2** Madeira **3** Canary islands.

of the second species described in the genus, *N. florentzae* Tabacaru, 1975, hitherto known from Romania and Moldova, is not certain and since there are no other records of *N. endogeus* in nature it might be an introduced species.

7.2.5. Pathways for the introduction of alien myriapod species in Europe

All of the alien myriapods have most probably been accidentally introduced to Europe with plant material in relation to human activities and trade between Europe and other continents such as Asia, Australasia and the Americas. This process must have begun with an increase in trade between ancient Greek and Romans with cities in Asia Minor and North Africa and should have intensified in post-medieval times with the trade between Europe and some East Asiatic countries (e.g. Japan, China) and the geographic discoveries of the Americas and, later, of Australia. This process is still going on with

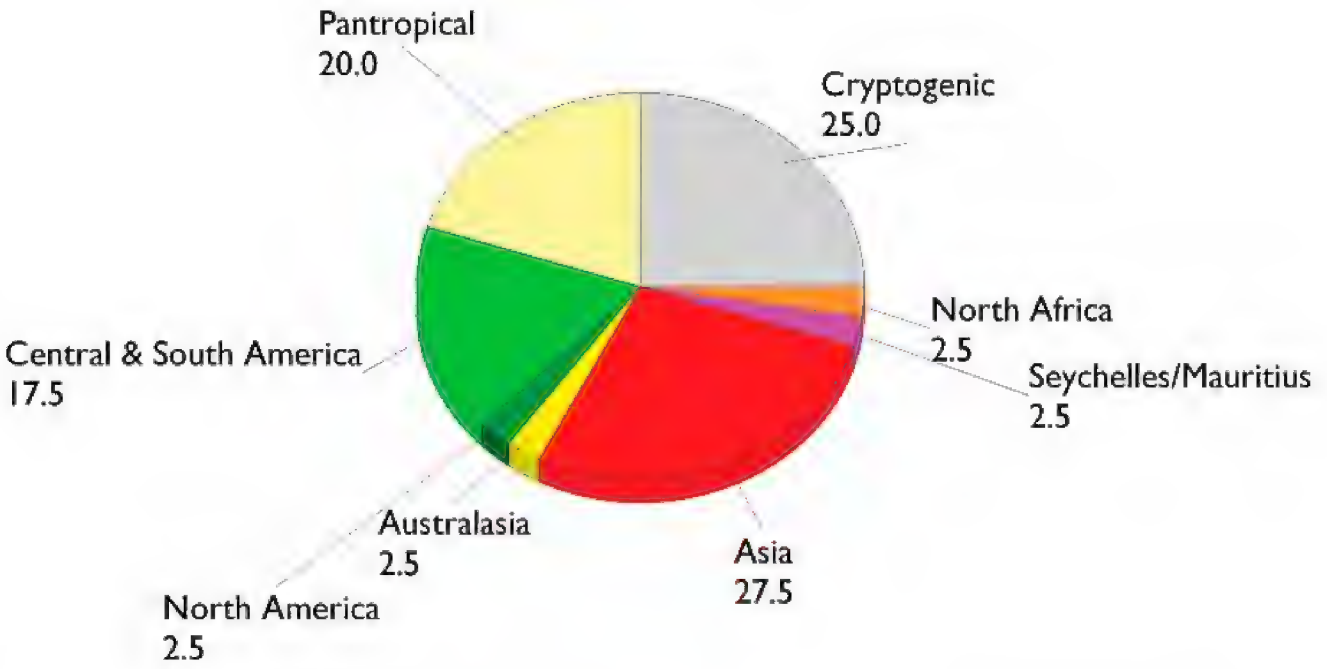

Figure 7.2.3. Geographic origin of the myriapod species alien to Europe (in percent).

the trade of tropical flowers and other plants and their cultivation in houses and greenhouses or with the importing of goods from tropical countries. Even large species could be transported this way, as is the recent case of the discovery of the largest centipede *Scolopendra gigantea*, found in 2005 in a house in London, which is thought to have arrived with a cargo of electrical goods or fruit (BBC News 2005). Pocock (1906) suggested the possible countries whence a variety of alien species found in Kew Gardens were introduced with their host plants: India (*Scolopendra morsitans*, *Mecistocephalus guildingii*), Sri Lanka (*Chondromorpha kelaarti*), Barbados (*Anadenobolus monilicornis*), Saint Vincent Island (*A. vincenti*).

The distribution of the alien diplopods in Europe shows that all the species living here in greenhouses are much more widespread compared to e.g. the restricted outdoor species *Eurygyrus ochraceus*. It is also likely that the obligate thelytokous parthenogenesis (= sexual reproduction giving rise to females only) shown in continental Europe by several of the exotic millipedes and at least one of the centipedes has facilitated their survival during transport and their establishment on the continent. However, bisexual populations are known from the Azores and the Canary Islands for *Lamyctes emarginatus* (Enghoff 1975a). Species from other centipede orders, such as the mecistocephalid *Tygarrup javanicus* also presumably reproduce by parthenogenesis since so far only females have been found in the hothouse at the Eden project, in Great Britain (Barber 2009b).

The number of exotic diplopods in Europe is far smaller (3–4 times) than that of European species introduced to other continents. Apparently, this could mean that the arrival and, especially, becoming resident in Europe is much more difficult than the converse process. The asymmetry has probably nothing to do with quarantine controls at European borders. Instead, it may be due to specific ecological and biological patterns exhibited by the successful invaders. Many of the alien millipedes and centipedes which have successfully invaded Europe be-

Figure 7.2.4. *Scolopendra gigantea* Linnaeus, 1758 [Chilopoda: Scolopendromorpha: Scolopendridae] caught in 2005 in apartment in London, perhaps arrived with a cargo of electric goods or fruit. Source: BBC News: http://news.bbc.co.uk/go/em/fr/-/1/hi/england/london/4201634.stm

Figure 7.2.5. *Tygarrup javanicus* Attems, 1929 [Chilopoda: Geophilomorpha: Mecistocephalidae]. United Kingdom: Eden Project, Cornwall. Credit: Anthony Barber.

long to genera moderately rich to rich in species, such as *Poratia, Chondrodesmus, Lamyctes, Cryptops*, etc. A pertinent question arises as to why often only one species succeeds in establishing populations on foreign continents, sometimes becoming quite widespread to even cosmopolitan, whereas its rather numerous congeners fail to do so. Specific adaptive ecological patterns may be an issue, but, as noticed

Figure 7.2.6. *Rhinotus purpureus* (Pocock, 1894) [Diplopoda: Polyzoniida: Siphonotidae]. Japan: Minami-Daito. Credit: Zoltán Korsós.

Figure 7.2.7. *Eurygyrus ochraceus* C.L. Koch, 1847 [Diplopoda: Callipodida: Schizopetalidae]. Ukraine: Crimea. Credit: Kiril Makarov.

above, obligate or opportunist parthenogenesis is probably a major trait favoring dispersal at least because a single founder juvenile or female is sufficient to arrive at destination and found a population. It has to be noted that the successful myriapod invaders tend to be among the smallest species, thus being more easily transported, better fitted to find a suitable microhabitat, and sometimes requiring a shorter time and even a smaller number of developmental stages to reach maturity (Golovatch 2009).

Figure 7.2.8. *Chondrodesmus* cf. *riparius* Carl, 1914 [Diplopoda: Polydesmida: Chelodesmidae]. Denmark: Copenhagen. Credit: Gert Brovad.

Figure 7.2.9. *Oxidus gracilis* (C.L. Koch, 1847) [Diplopoda: Polydesmida: Paradoxosomatidae]. Italy: Porto Badino (Borgo Hermada – Terracina). Credit: Massimiliano Di Giovanni.

Figure 7.2.10. *Paraspirobolus lucifugus* (Gervais, 1836) [Diplopoda: Spirobolida: Spirobolellidae]. Japan: Okinawa. Credit: Zoltán Korsós.

Another possible pathway of the introduction of exotic myriapods to Europe is their intentional import as 'pets', and their further escape from pet keepers. Large *Scolopendra* spp., as well as some large and colorful millipedes of the orders Spirobolida, Spirostreptida and Sphaerotheriida are quite popular pet animals subjected to trade in pet shops. Although there are many guides and internet resources available for keeping and caring for exotic species, there is no reliable information about the importance of the 'pet' trade for the introduction of alien myriapods to Europe. However, the establishment of pet myriapods in the wild is in most cases very unlikely.

7.2.6. The most invaded ecosystems and habitats

Man-made artificial environments (pastures and cultivated lands, greenhouses, urban and suburban areas) constitute the main habitat types hosting alien myriapods (Table 7.2.1). Species of tropical and subtropical origin are likely to be restricted to greenhouses or equivalent artificially warmed habitats. Some of them, in the summer season in the southern countries perhaps could survive also outdoors in close proximity to the hothouses. However, 11 species have been reported from natural habitats in Europe, where they most likely were able to establish viable populations. So far the alien species of symphylans and pauropods are unknown in natural areas, which is not the case with several species of the other two myriapod classes. The millipede *Oxidus gracilis*, which is bisexual everywhere and is naturalized in several areas in Europe and in the Caucasus, has been found in forests close to suburban and urban areas (Tömösváry 1879), in woodlands of *Robinia pseudoacacia* in the Kanev Nature Reserve, Ukraine

Figure 7.2.11. *Trigoniulus corallinus* (Gervais, 1847) [Diplopoda: Spirobolida: Trigoniulidae]. Taiwan. Credit: Zoltán Korsós.

(Chornyi and Golovatch 1993) and records from caves also exist (Strasser 1974, Vicente and Enghoff 1999). On the Canary Islands the species is quite widespread invading various, mostly dry and warm, habitats (Arndt et al. 2008). According to Palmén (1949), *O. gracilis* dies when subjected for 2 hours to a temperature of minus 4°C. This means that in North Europe the species can survive only in hothouse conditions. *Cylindroiulus truncorum* mainly inhabits synanthropic habitats: greenhouses, gardens, parks, woodpiles, school grounds, cemeteries, spoil heaps, horticultural nurseries (Kime 2004, Korsós and Enghoff 1990).

Eurygyrus ochraceus occurs in the Crimea only in a patch of semi-natural xerophytic vegetation ca. 1 km long and 100–300 m wide along a watershed. It was reported to be rather common, although not too abundant on the site and is definitely an anthropochore (Golovatch 2008).

Lamyctes emarginatus shows remarkable plasticity regarding the surrounding environment, although in the British Isles there is preponderance of rural records in comparison with (sub)urban ones. In artificial habitats it has been reported from gardens, roads, roadside verges, hedges, embankments, crops of *Zea mays* and *Medicago sativa*, even in human rubbish (Eason 1964, Minelli and Iovane 1987, Barber and Keay 1988). In natural habitats it lives in various woods (deciduous or mixed coniferous/deciduous) and has also been recorded from open and coastal areas (Barber and Keay 1988, Zerm 1997, Zapparoli 2006). According to Andersson (2006), it predominates in open and disturbed areas with sparse vegetation. A great many of these localities

are associated with lake shores, river gravels or river banks. *L. emarginatus* shows clear preferences for temporarily flooded sites, no matter for how long the inundation lasts. Its appearance as a pioneer species on mine sites may indicate that the species shows preference to disturbed habitats (Zerm 1997). In close proximity to water pools the species abundance can reach 95% of all centipedes (Minoranskii 1977).

Two of the (presumed) alien geophilomorphs, *Arenophilus peregrinus* and *Nothogeophilus turki,* have been recorded in coastal areas, where they occur under stones and in soil close to rocky sea cliffs with sparse vegetation although *A. peregrinus* has been found inland in Cornwall in woodland and one of the Isle of Wight records for *Nothogeophilus turki* was from an area of demolished buildings with copious rubbish on the ground although no more than 5 m from the tidal river (A.N. Keay *pers. comm.).*

Considerable fluctuation in the abundance of some alien species have been observed by Barber (2009b) in the tropical hothouse of the Eden Project. *P. lucifugus* which was not found in 2003/4, was rather restricted in its occurrence in 2005, had become abundant throughout by 2009. Likewise, *C. doriae* which has been relatively uncommon and limited in occurrence in 2005 was the dominant species there in 2009. Conversely, *T. javanicus*, which had been abundant in 2005, was difficult to find in 2009 (Barber 2009b).

7.2.7. Ecological and economic impact

Alien myriapods are unlikely to pose major threats to native biodiversity and ecosystems. The number of species established in the wild being very limited (12 species, *ca* 30%) for the moment (Table 7.2.1). Diplopods are detrivorous animals, consuming 10–15% of the leaf litter in temperate forest and as thus contribute significantly to soil formation processes through the fragmentation of leaves which stimulates microbial activity. They may thus indirectly influence the fluxes of nutrients (Hopkin and Read 1992). Nevertheless, some alien diplopods could be harmful to cultivated plants, especially in the artificial habitats where temperature and humidity conditions allow species establishment and expansion. Invasive soil invertebrates may also have an impact on the structure and function of natural ecosystems. They can change soil carbon, nitrogen and phosphorus pools and can considerably affect the distribution and function of roots and micro-organisms (Arndt and Perner 2008). In addition, mass occurrences and swarming, which have been observed in several countries in Europe, may have negative ecological and economic impact although the causes still remain obscure (Sahli 1996, Voigtländer 2005). An example of a plant-damaging alien myriapod is *Oxidus gracilis*, which is regarded as a pest in several European countries. This species is very common in greenhouses where its density may exceed 2500 ind./m^2. It is known for attacking vegetable and fruit crops such as sugar beet, potatoes, strawberries, cucumbers, orchard fruits, roots of wheat, and flowers in outdoor cultivated areas. Furthermore, several thousand *O. gracilis* were once found after rain in a house in Lenoir City, Tennessee, USA, with most of the city infested during the same outbreak (Hopkin and Read 1992). As a curiosity, one might also mention the report

by the classical writer Theophrastus, according to whom an army of millipedes once overran Rhoeteum in the present province of Çanakkale (northwestern Turkey) and drove its human inhabitants into the sea (Sharples 1994, Enghoff and Kebapći 2008).

Several plants can withstand the attacks of symphylans but they may cause severe damage to growing crops both in fields and greenhouses (Scheller 2002). Arndt and Perner (2008) recently carried out a study on the impact of invasive ground-dwelling predatory species, including alien centipedes, in the native laurel forest habitat in the Canary Islands. They found that centipedes in laurel forests seem to be much more variable than carnivorous ground beetles since the 14 recorded species include representatives of three orders with very different characters. They tentatively recognised four functional groups of centipedes: a micro-cephalic schendylid type, (ii) a geophilid type with medium head size and extreme body length, (iii) a scolopendromorph type, and (iv) a macro-cephalic lithobiomorph type. These groups suggest patterns of invasion similar to the coleopteran predators: autochthonous and introduced species of the same size class and group are mutually exclusive (Arndt 2006).

The potential role of tropical giant millipedes and centipedes (*Scolopendra* spp.) kept as pets has been little analyzed as a source of health problems in relation to their defensive fluids or their bites which can cause pathological reactions if exposed to skin, mouth/throat or eyes (Rein 2002).

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Table 7.2.1. List and main characteristics of the myriapod species alien to Europe. Status: **A** Alien to Europe **C** cryptogenic species. Country codes abbreviations refer to ISO 3166 (see Appendix I). Habitat abbreviations refer to EUNIS (see Appendix II). Only selected references are given. Last update 10/03/2010.

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
Pauropoda								
	Tetramerocerata							
	Pauropodidae	*Allopauropus pseudomillotianus* Remy & Balland, 1958	A	Southeast Asia (India, Sri Lanka)	1958, FR	FR, NO	J100	Andersson et al. (2005)
Symphyla								
	Symphylomorpha							
	Scutigerellidae	*Hanseniella caldaria* (Hansen, 1903)	A	Tropical, subtropical (North America up to Mexico, South America, sub-Saharan Africa, Sri Lanka, Galapagos Islands, and possibly New Zealand)	1903, DK	DK, FR, GB, MC, NO	J100	Andersson et al. (2005), Scheller (2002), Shear and Peck (1992)
		Hanseniella oligomacrochaeta Scheller, 2002	C	Unknown. Tropical, subtropical?	2000, DE	DE	J100	Scheller (2002)
		Hanseniella orientalis (Hansen, 1903)	A	Tropical, subtropical (South and southeastern Asia, Central and South America, islands in the Pacific)	2000, DE	DE	J100	Scheller (2002)
Chilopoda								
	Geophilomorpha							
	Mecistocephalidae	*Mecistocephalus guildingii* Newport, 1843	A	Amphi-Atlantic (coasts of Tropical America, African coast from Gambia to Liberia, Atlantic islands)	1895, DE	DE, FR, GB, PT-MAD	J100	Bonato et al. (2009), Pocock (1906)
		Mecistocephalus maxillaris (Gervais, 1837)	C	Unknown, tropical?	1837, FR	DK, FR, NL	J100	Andersson et al. (2005), Bonato et al. (2009), Jeekel (1977)
		Tygarrup javanicus Atems, 1929	A	Southeast Asia (Java, Vietnam, Cambodia), The Seychelles	1975, GB	AT, GB	J100	Barber (2009b), Christian (1996), Lewis and Rundle (1988)

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
	Geophilidae	*Arenophilus peregrinus* Jones, 1989	C	Unknown, genus present in North America	1986, GB	GB	B3, I2	Barber (2009a), Gregory and Jones (1999), Jones (1989)
		Nothogeophilus turki Lewis, Jones & Keay, 1988	C	Unknown	1985, GB	GB	B3	Barber (2009a), Lewis et al. (1988)
	Oryidae	*Orphnaeus brevilabiatus* (Newport, 1845)	A	Tropical, subtropical (Australia, Central and South America, Sub-Saharan Africa, Madagascar, East Asia, Arabian Peninsula, Hawaii)	19th century, SE	SE	Un-known, J100?	Andersson et al. (2005)
	Schendylidae	*Nyctunguis persimilis* Attems, 1932	C	Unknown. Genus present in North America	1996, AT	AT	I2?	Christian (1996), Christian and Szeptycki (2004), Gruber and Christian (2002)
Chilopoda								
Scolopendromorpha								
	Cryptopidae	*Cryptops doriae* Pocock, 1891	A	Southeast Asia, Papua New Guinea, The Seychelles	2007, GB	GB	J100	Barber (2009a), Lewis (2007)
	Scolopendridae	*Scolopendra gigantea* Linnaeus, 1758	A	Central and South America	2005, GB	GB	J1	BBC News (2005)
		Scolopendra morsitans Linnaeus, 1758	A	Tropical, subtropical. North and South America, Atlantic Ocean Islands, Europe, Africa, Arabian Peninsula, Southeast Asia, Indian Ocean Islands, Australia, New Zealand, Pacific Islands	1902, GB	GB	J100	Akkari et al. (2008), Pocock (1906)
		Scolopendra subspinipes Leach, 1815	A	East and South Asia	1902, GB	GB	J100	Minelli (2006), Pocock (1906)

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
Chilopoda								
	Lithobiomorpha							
	Henicopidae	*Ghilaroviella* cf. *valiachmedovi* Zalesskaja, 1975	A	Unknown. *G. valiachmedovi* occurs in Central Asia (Tajikistan)	2004, AT	AT	I2	Christian and Szeptycki (2004)
		Lamyctes (*Metalamyctes*) *albipes* (Pocock, 1895)	C	Southeast Asia (Java), Sakhalin Island, Guadeloupe, The Seychelles	1988, ES-CAN	ES-CAN	H3, H5	Eason and Enghoff (1992), Hollington and Edgecombe (2004)
		Lamyctes (*Lamyctes*) *coeculus* (Brölemann, 1889)	A	Tropical, subtropical. Known from Australia, Central and South America, Sub-Saharan Africa, Madagascar	1889, IT	DK, ES-CAN, FI, FR, GB, IT, SE	J100, J	Barber (2009a), Enghoff (1975a), Zapparoli and Minelli (2005)
		Lamyctes (*Lamyctes*) *emarginatus* (Newport, 1844)	A	Australasia (Australia+ New Zealand) is the possible areas of origin. Known also from North and South America, Africa, Asia Minor, Greenland, Iceland, New Caledonia, islands in the Pacific	1868, DK	AT, BE, BG, CZ, DE, DK, ES-CAN, FI, FR, GB, GL, GR, HU, IT, LU, NL, NO, PL, PT, PT-AZO, PT-MAD, RO, RU, SE, SK, UA	B1, D, E, F4, F9, G1, G3, J1, J2, J3, J4, J5, J6, I, I1, I2, X6, X7, X23	Barber and Keay (1988), Bocher and Enghoff (1984), Meinert (1868), Minelli and Iovane (1987), Negrea (1989), Palmén (1948, 1952), Zapparoli and Minelli (2005)
		Rhodobius lagoi Silvestri, 1933	C	Unknown, possibly tropical, subtropical. Subfamily Anapsobiinae distributed in South America, South Africa, Australia, Japan, Vietnam, Kazakhstan and Tajikistan	1933, GR-SEG	GR-SEG (Rhodes)	I ?	Silvestri (1933), Zapparoli (2002)

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
Diplopoda ***Polyxenida***								
	Polyxenidae	*Polyxenus fasciculatus* Say, 1821	A	Nearctic (USA), Bermuda Islands	1961, PT-MAD	ES-CAN, PT-MAD	G	Attems (1935), Condé (1961), Vicente and Enghoff (1999)
Diplopoda ***Polyzoniida***								
	Siphonotidae	*Rhinotus purpureus* (Pocock, 1894)	A	Tropical, subtropical (South and Central America, islands in Indian and Pacific oceans)	1986, GB	GB	J100	Barber (2010), Read (2008)
Diplopoda ***Callipodida***								
	Schizopetalidae	*Eurygyrus ochraceus* C.L. Koch, 1847	A	Asia (Turkey)	1925, BG	BG, UA	E1, I2	Golovatch (2008), Stoev (2007), Verhoeff (1926)
Diplopoda ***Polydesmida***								
	Chelodesmidae	*Chondrodesmus* cf. *riparius* Carl, 1914	A	South America	2000, SE	DE, DK, NO, SE	J	Andersson and Enghoff (2007), Enghoff (2008a)
	Haplodesmidae	*Cylindrodesmus hirsutus* Pocock, 1889	A	Tropical, subtropical (South America, Southeast Asia, Papua New Guinea, islands in Indian and Pacific oceans)	1950-1985	AT, DE, FR, GB, HU, SK	J100	Golovatch and Stoev (2010), Golovatch et al. (2001), Golovatch et al. (2009), Read (2008)
		Prosopodesmus panporus Blower & Rundle, 1980	A	Unknown, other species in the genus pantropical	1975, GB	GB	J100	Blower and Rundle (1980), Golovatch et al. (2009), Read (2008)

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
	Oniscodesmidae	*Amphitomeus attemsi* (Schubart, 1934)	A	South America (Venezuela or Colombia)	1930, DE	AT, CH, DE, DK, GB, HU, NL, PL, SK	J100	Barber and Eason (1986), Enghoff (1987), Enghoff (2009), Golovatch et al. (2002), Gruber (2002), Korsós et al. (2002)
	Paradoxosomatidae	*Asiomorpha coarctata* (De Saussure, 1860)	A	Southeast Asia	1906, GB	GB	J100	Pocock (1906)
		Chondromorpha kelaarti (Humbert, 1865)	A	India, Sri Lanka	1902, GB	GB	J100	Pocock (1906)
		Oxidus gracilis (C.L. Koch, 1847)	A	Asia (East or Southeast)	1879, HU	AT, BE, BG, BY, CH, CZ, DE, DK, ES, ES-BAL, ES-CAN, FI, FR, GB, HU, IE, IS, IT, LT, LU, LV, MC, MD, MK, MT, NL, NO, PL, PT-MAD, PT-AZO, RO, RU, SE, SI, SK, UA	J, J100, G	Blower (1985), Enghoff (2009), Enghoff et al. (2004), Evans (1900), Hoffman (1999), Pocock (1902), Read (2008), Šefrová and Laštůvka (2005), Stoev (2004)
	Pyrgodesmidae	*Cynedesmus formicola* (Cook, 1896)	C	Unknown, genus native of Central America	1896, ES-CAN	ES-CAN, HU, PT-MAD	J100	Attems (1935), Korsós et al. (2002), Vicente and Enghoff (1999)
		Poratia digitata (Porat, 1889)	A	Tropical and subtropical (Southern North and Central America)	1889, SE	AT, CH, DE, DK, FR, GB, NL, NO, SE	J100	Blower and Rundle (1986), Golovatch and Sierwald (2001), Gruber (2002), Latzel (1895)

Class *Order*	Family	Species	Status	Native range	1st record in Europe	Invaded countries	Habitat	References
		Poratia obliterata (Kraus, 1960)	A	Tropical (South and Central America: Peru, Colombia, Brazil, Costa Rica)	late 1990s, DE	DE, FR, HU	J100	Adis et al. (2000), Golovatch and Sierwald (2001), Korsós et al. (2002)
	Trichopolydesmidae	*Napocodesmus endogeus* Ceuca, 1974	C	Unknown, only female/s known; the second tentative congener occurs in Romania and Moldova	1969, RO	RO	I2?	Ceuca (1974), Tabacaru et al. (2003)
Diplopoda ***Julida***								
	Julidae	*Cylindroiulus truncorum* (Silvestri, 1896)	A	North Africa (Algeria, Tunisia)	1925, DE	AT, BE, CH, DE, DK, ES-CAN, FI, FR, GB, HU, LT, LU, NL, NO, PL, PT, PT-MAD, RO, SE, UA	J, J100, I2	Enghoff (2009), Kime (2004), Korsós and Enghoff (1990), Read (2008), Schubart (1925)
Diplopoda ***Spirobolida***								
	Pseudospiro-bolellidae	*Pseudospirobolellus avernus* (Butler, 1876)	A	Tropical (Southeast Asia, islands in Indian and Pacific oceans, and Caribbean Sea)	2009, GB	GB	J100	Barber et al. (2010), Enghoff (2001)
	Rhinocricidae	*Anadenobolus monilicornis* (Porat, 1876)	A	Caribbean region	1906, GB	GB	J100	Hoffman (1999), Pocock (1906)
		Anadenobolus vincenti (Pocock, 1894)	A	Saint Vincent Island, Lesser Antilles	1900, GB	GB	J100	Hoffman (1999), Pocock (1906)
	Spirobolellidae	*Paraspirobolus lucifugus* (Gervais, 1836)	A	Tropical. Area of origin most likely The Seychelles and/or Mauritius	1836, FR	DE, DK, GB, NL	J100	Enghoff (1975b), Jeekel (2001), Latzel (1895), Lee (2006), Read (2008)
	Trigoniulidae	*Trigoniulus corallinus* (Gervais, 1847)	A	Southeast Asia	1902, GB	GB	J100	Pocock (1906), Shelley and Lehtinen (1999)

Table 7.2.2 List of myriapod species intercepted in Great Britain (Barber 2009a, Clarke 1938, John Lewis, *pers. comm.*, Sharon Reid (FERA), *pers. comm.*)

Species	Native Range	Found in/ Country of dispatch/ Year of Interception
Class Chilopoda		
Order Craterostigmomorpha		
Craterostigmus sp.	New Zealand & Tasmania	*Dicksonia* (Australia or New Zealand, 2008)
Order Geophilomorpha		
?*Zelanion* (= *Steneuryton*) sp.	Australia, New Zealand, Hawaii	*Dicksonia* (Australia, 2005)
Order Scolopendromorpha		
Scolopendra cingulata Latreille, 1829	Mediterranean region	With luggage (Spain, 2003), potatoes (Greece, 1975), Turkey (2004), Palestine (pre-1992)
Scolopendra dalmatica C.L. Koch, 1847	Balkan peninsula	Found in fruit & vegetable warehouse on Isle of Wight (1983)
Scolopendra subspinipes subspinipes Leach, 1815	Asia, Africa, C. & S. America	*Trachycarpus wagnerianus* (South Korea, 2006), bananas (Jamaica, 1938)
Order Lithobiomorpha		
Lithobius forficatus (Linneaus, 1758)	Europe	*Dicksonia* (Australia, 2004)
Lithobius peregrinus Latzel, 1880	Europe, Caucasus	*Dicksonia* (New Zealand, 2004)
Class Diplopoda		
Order Polydesmida		
Polydesmida gen. spp.		*Dracaena fragans* (Belgium, 1979)
?*Gasterogramma plomleyi* Mesibov, 2003	Tasmania	*Dicksonia* (Australia, 2004)
?*Mestosoma* sp.		Bromeliad (Ecuador, 1982)
Akamptogonus novarae (Humbert & Saussure, 1869)	? Australia	*Dicksonia* (New Zealand, 2004)
Habrodesmus falx Cook, 1896	West Africa	Tete leaves (Nigeria, 1981)
Habrodesmus sp.		Orchid (Malawi, 1982)
?*Oxidus gracilis*	?East Asia	Zelkova (Netherlands, 1995)
Oxidus gracilis	East Asia	Aroid (USA,1980), *Chaemaerops* (Morocco, 2001), *Cryptomeria* (Japan, 1979), *Dracaena* (Belgium, 1979), *Ficus* (West Africa, 1979), *Hibiscus* (Canary Is.), *Lirope* (USA, 1999), Orchid (Belize, 1980; Madagascar, 1995; Malaysia,1984; India, 2000), Palm (Canary Is., 1998), *Pentas* (Canary Is., 2010), *Phoenix* (USA, 1995), *Rhododendron* (soil, Nepal, 1981), *Sanseviera* (USA, 1980), *Scindapus* (soil, Nepal, 1981), *Selaginella* (Singapore, 1999; Brazil, 1995), *Serissa* (China, 1999, 2004), *Trachycarpus* (Netherlands, 2008), *Washingtonia* (Italy, 2009), Weeping fig (USA, 1984), *Yucca* (?Netherlands, 1980), *Zamia* seed (USA, 1982), *Zelkova* (China, 1995), unknown (Chile, 1998; South Africa, 2001)

Species	Native Range	Found in/ Country of dispatch/ Year of Interception
Polydesmidae		*Dicksonia* (Australia, 2005; New Zealand, 2004), Orchid (Malaysia, 1983), Wild Plant (South Africa, 1983)
Polydesmus sp.		*Miscanthus* (Dominica, 2000), Orchid (Australia, 1985)
Order Spirostreptida		
Spirostreptida		*Cyathea* (New Zealand, 2005), *Dicksonia* (Australia, 2004–2008), *Dracaena* (Rwanda, 1980)
Spirostreptus sp.		Fig (Ivory Coast, 1983)
Plusioglyphiulus sp.		Orchids & Rhododendrons (Borneo, 1979)
Order Julida		
Blaniulidae		*Echinodorus* (Singapore, 2008), Orchid (Brazil, 2003)
Blaniulus guttulatus (Fabricus, 1798)	Europe	Orchid (Australia, 1985)
Blaniulus sp.		Unknown (South Africa, 1999)
Cylindroiulus londinensis (Leach, 1814)	Europe	*Phoenix dactylifera* (Italy, 2004)
Cylindroiulus sp.		*Dicksonia* (New Zealand, 2004)
Ommatoiulus moreletii (Lucas, 1860)	Iberian peninsula	*Dicksonia* (Australia, 2006), melon fruit (South Africa, 1983)
Ommatoiulus oxypygus (Brandt, 1841)	Italy	*Vitis* sp. (Italy, 1979)
Ophyiulus targionii Silvestri, 1898	Italy	Unknown (New Zealand, 1982)

Table 7.2.3. Relative importance of the non-native species in the myriapod fauna of the Macaronesian islands. The numbers of introduced species correspond to the total non-native species of both exotic and continental European origin (cf., Arndt et al. 2008, Baéz and Oromí 2004, Borges, 2008a,b, Borges and Enghoff 2005, Enghoff 2008b, Enghoff and Borges 2005, Zapparoli and Oromi 2004), some numbers updated according to recent records. * 7 certainly native, 6 probably native, 20 possibly native, ** all probably introduced; *** all possibly native.

	Canary Isl.		Azores Isl.		Madeira Is.		Selvages Isl.	
	Native	Introduced	Native	Introduced	Native	Introduced	Native	Introduced
Diplopoda	83	24	2	19	40	18	2	0
Chilopoda	33*	2**	8	3	2	17+2?	0	2
Symphyla	0	6**	3	0	1	2	no records	no records
Pauropoda	14***	0	1	0	10	0	no records	no records